

What is Claimed is:

1. A polarimeter, comprising:

a receiver that is configured to:

receive a first polarization (P1) of a signal and to split the first  
5 polarization of the signal into the in-phase ( $I_{P1}$ ) and quadrature ( $Q_{P1}$ ) components;  
and

receive a second polarization (P2) of the signal and to split the second  
polarization of the signal into the in-phase ( $I_{P2}$ ) and quadrature ( $Q_{P2}$ ) components;  
and

10 a processor that is configured to:

receive each of the in-phase and quadrature components ( $I_{P1}$ , ( $Q_{P1}$ ),  
( $I_{P2}$ ), and ( $Q_{P2}$ )) of the first and second polarizations; and

determine the Stokes polarization vector components ( $s_0$ ,  $s_1$ ,  $s_2$ , and  $s_3$ )  
of the signal.

2. The polarimeter of claim 1 wherein the Stokes polarization vector components ( $s_0$ ,  
 $s_1$ ,  $s_2$ , and  $s_3$ ) of the signal are determined by:

$$s_0 = a_{P1}^2 + a_{P2}^2;$$

5  $s_1 = a_{P1}^2 - a_{P2}^2;$

$$s_2 = 2a_{P1}a_{P2}\cos\delta; \text{ and}$$

$$s_3 = 2a_{P1}a_{P2}\sin\delta;$$

Where:

$$\delta = \delta_{P1} - \delta_{P2};$$

$$\delta_i = \tan^{-1}(Q_i/I_i); \text{ for } i=P1, P2; \text{ and}$$

$$a_i^2 = I_i^2 + Q_i^2; \text{ for } i=P1, P2.$$

3. The polarimeter of claim 2, wherein the first polarization (P1) is orthogonal to the second polarization (P2).

4. The polarimeter of claim 3, further comprising an antenna and wherein the receiver comprises:

5 a polarizer operatively connected with the antenna and comprising a first output and a second output;

a first receiver/demodulator operatively connected with the first output of the polarizer and being configured to receive and demodulate the first polarization of the signal; and

10 a second receiver/demodulator operatively connected with the second output of the polarizer and being configured to receive and demodulate the second polarization of the signal.

5. The polarimeter of claim 4 wherein the first receiver/demodulator comprises:

a first reference oscillator;

a first local oscillator operatively connected with the first reference oscillator;

5 a first mixer which receives input from the polarizer and the first local oscillator;

a first amplifier operatively connected with the polarizer;  
a first splitter operatively connected with the first amplifier and functioning to  
separate the in-phase ( $I_{P1}$ ) and quadrature ( $Q_{P1}$ ) components;  
a first in-phase mixer operatively connected with the first reference oscillator  
5 and operatively connected with the first splitter to receive the in-phase ( $I_{P1}$ )  
component;  
a first phase shifter operatively connected with the first reference oscillator;  
and  
a first quadrature mixer operatively connected with the first phase shifter and  
10 operatively connected with the first splitter to receive the quadrature ( $Q_{P1}$ )  
component.

6. The polarimeter of claim 5 wherein the second receiver/demodulator comprises:  
a second reference oscillator;  
a second local oscillator operatively connected with the second reference  
5 oscillator;  
a second mixer which receives input from the polarizer and the second local  
oscillator;  
a second amplifier operatively connected with the polarizer;  
a second splitter operatively connected with the second amplifier and  
10 functioning to separate the in-phase ( $I_{P2}$ ) and quadrature ( $Q_{P2}$ ) components;

a second in-phase mixer operatively connected with the second reference oscillator and operatively connected with the second splitter to receive the in-phase ( $I_{P2}$ ) component;

5 a second phase shifter operatively connected with the second reference oscillator; and

a second quadrature mixer operatively connected with the second phase shifter and operatively connected with the second splitter to receive the quadrature ( $Q_{P2}$ ) component.

7. The polarimeter of claim 1 further comprising an analog to digital converter operatively connected between the receiver and the processor.

8. A method for receiving a signal and determining a state of polarization of the signal, comprising:

receiving a first polarization ( $P1$ ) of the signal;

5 splitting the first polarization of the signal into the in-phase ( $I_{P1}$ ) and quadrature ( $Q_{P1}$ ) components;

receiving a second polarization ( $P2$ ) of the signal;

splitting the second polarization of the signal into the in-phase ( $I_{P2}$ ) and quadrature ( $Q_{P2}$ ) components; and

10 determining the Stokes polarization vector components ( $s_0$ ,  $s_1$ ,  $s_2$ , and  $s_3$ );

where:

$$s_0 = a_{P1}^2 + a_{P2}^2;$$

$$s_1 = a_{P1}^2 - a_{P2}^2;$$

$$s_2 = 2a_{P1}a_{P2}\cos\delta; \text{ and}$$

$$s_3 = 2a_{P1}a_{P2}\sin\delta;$$

given:

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$$\delta = \delta_{P1} - \delta_{P2};$$

$$\delta_i = \tan^{-1}(Q_i/I_i); \text{ for } i=P1, P2; \text{ and}$$

$$a_i^2 = I_i^2 + Q_i^2; \text{ for } i=P1, P2.$$

9. A computer program for determining a state of polarization of a signal, the computer program being embodied on a computer readable medium and, the computer program comprising:

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receiving as input in-phase ( $I_{P1}$ ) and quadrature ( $Q_{P1}$ ) components of a first polarization (P1) of the signal;

receiving as input in-phase ( $I_{P2}$ ) and quadrature ( $Q_{P2}$ ) components of a second polarization (P2) of the signal; and

determining the Stokes polarization vector components ( $s_0$ ,  $s_1$ ,  $s_2$ , and  $s_3$ );

10

where:

$$s_0 = a_{P1}^2 + a_{P2}^2;$$

$$s_1 = a_{P1}^2 - a_{P2}^2;$$

$$s_2 = 2a_{P1}a_{P2}\cos\delta; \text{ and}$$

$$s_3 = 2a_{P1}a_{P2}\sin\delta;$$

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given:

$$\delta = \delta_{P1} - \delta_{P2};$$

$$\delta_i = \tan^{-1}(Q_i/I_i); \text{ for } i=P1, P2; \text{ and}$$

$$a_i^2 = I_i^2 + Q_i^2; \text{ for } i=P1, P2.$$

10. A device for transmitting a signal and determining a state of polarization of a reflected signal, comprising:

a transmitter for transmitting a signal;

5 a receiver for receiving a reflected signal and that is configured to:

receive a first polarization (P1) of the reflected signal and to split the first polarization of the reflected signal into the in-phase ( $I_{P1}$ ) and quadrature ( $Q_{P1}$ ) components; and

10 receive a second polarization (P2) of the reflected signal and to split the second polarization of reflected signal into the in-phase ( $I_{P2}$ ) and quadrature ( $Q_{P2}$ ) components; and

a processor that is configured to:

receive each of the in-phase and quadrature components ( $I_{P1}$ ,  $Q_{P1}$ ,  $I_{P2}$ , and  $Q_{P2}$ ) of the first and second polarizations; and

15 determine the Stokes polarization vector components ( $s_0$ ,  $s_1$ ,  $s_2$ , and  $s_3$ ) of the reflected signal.

11. The device of claim 10 wherein the Stokes polarization vector components ( $s_0$ ,  $s_1$ ,  $s_2$ , and  $s_3$ ) of the signal are determined by:

$$s_0 = a_{P1}^2 + a_{P2}^2;$$

5  $s_1 = a_{P1}^2 - a_{P2}^2;$

$$s_2 = 2a_{P1}a_{P2}\cos\delta; \text{ and}$$

$$s_3 = 2a_{P1}a_{P2}\sin\delta;$$

Where:

$$\delta = \delta_{P1} - \delta_{P2};$$

$$\delta_i = \tan^{-1}(Q_i/I_i); \text{ for } i=P1, P2; \text{ and}$$

$$a_i^2 = I_i^2 + Q_i^2; \text{ for } i=P1, P2.$$

12. The device of claim 11, wherein the first polarization (P1) is orthogonal to the second polarization (P2).

13. The device of claim 12, further comprising:

an antenna; and

a circulator operatively connected with the antenna and being configured to separate a transmitted signal from a received signal.

14. The device of claim 13, wherein the receiver comprises:

a polarizer operatively connected with the antenna and comprising a first output and a second output;

a first receiver/demodulator operatively connected with the first output of the polarizer and being configured to receive and demodulate the first polarization of the signal; and

a second receiver/demodulator operatively connected with the second output of the polarizer and being configured to receive and demodulate the second polarization of the signal.

15. The device of claim 14, wherein the first receiver/demodulator comprises:

a first reference oscillator;

a first local oscillator operatively connected with the first reference oscillator;

5 a first mixer which receives input from the polarizer and the first local oscillator;

a first amplifier operatively connected with the polarizer;

a first splitter operatively connected with the first amplifier and functioning to separate the in-phase ( $I_{P1}$ ) and quadrature ( $Q_{P1}$ ) components;

10 a first in-phase mixer operatively connected with the first reference oscillator and operatively connected with the first splitter to receive the in-phase ( $I_{P1}$ ) component;

a first phase shifter operatively connected with the first reference oscillator;  
and

15 a first quadrature mixer operatively connected with the first phase shifter and operatively connected with the first splitter to receive the quadrature ( $Q_{P1}$ ) component.

16. The device of claim 15, wherein the second receiver/demodulator comprises:

a second reference oscillator;

a second local oscillator operatively connected with the second reference oscillator;

a second mixer which receives input from the polarizer and the second local oscillator;

5 a second amplifier operatively connected with the polarizer;

a second splitter operatively connected with the second amplifier and functioning to separate the in-phase ( $I_{P2}$ ) and quadrature ( $Q_{P2}$ ) components;

a second in-phase mixer operatively connected with the second reference oscillator and operatively connected with the second splitter to receive the in-phase

10 ( $I_{P2}$ ) component;

a second phase shifter operatively connected with the second reference oscillator; and

a second quadrature mixer operatively connected with the second phase shifter and operatively connected with the second splitter to receive the quadrature

15 ( $Q_{P2}$ ) component.

17. The device of claim 16, wherein the transmitter comprises a third reference oscillator and the first and second reference oscillators are phase-locked with the first and second local oscillators and with the third reference oscillator.

18. The device of claim 11, wherein the transmitter and the receiver operate at radar frequencies.

19. The device of claim 18, wherein the transmitter and the receiver operate at ladar frequencies.

20. The device of claim 19, further comprising an antenna and wherein the receiver comprises:

5 a polarizer operatively connected with the antenna and comprising a first output and a second output;

a first receiver/demodulator operatively connected with the first output of the polarizer and being configured to receive and demodulate the first polarization of the signal; and

10 a second receiver/demodulator operatively connected with the second output of the polarizer and being configured to receive and demodulate the second polarization of the signal.

21. The device of claim 20, wherein the first receiver/demodulator comprises:

a first reference oscillator;

5 a first acousto-optic modulator operatively connected with the first reference oscillator and the transmitter;

a first mixer which receives input from the polarizer and the first acousto-optic modulator;

a first amplifier operatively connected with the polarizer;

10 a first splitter operatively connected with the first amplifier and functioning to separate the in-phase ( $I_{P1}$ ) and quadrature ( $Q_{P1}$ ) components;

a first in-phase mixer operatively connected with the first reference oscillator and operatively connected with the first splitter to receive the in-phase ( $I_{P1}$ ) component;

a first phase shifter operatively connected with the first reference oscillator;  
5 and

a first quadrature mixer operatively connected with the first phase shifter and operatively connected with the first splitter to receive the quadrature ( $Q_{P1}$ ) component.

22. The device of claim 21, wherein the second receiver/demodulator comprises:

a second reference oscillator;  
a second acousto-optic modulator operatively connected with the second  
5 reference oscillator and the transmitter;

a second mixer which receives input from the polarizer and the second acousto-optic modulator;

a second amplifier operatively connected with the polarizer;  
a second splitter operatively connected with the second amplifier and

10 functioning to separate the in-phase ( $I_{P2}$ ) and quadrature ( $Q_{P2}$ ) components;

a second in-phase mixer operatively connected with the second reference oscillator and operatively connected with the second splitter to receive the in-phase ( $I_{P2}$ ) component;

a second phase shifter operatively connected with the second reference  
15 oscillator; and

a second quadrature mixer operatively connected with the second phase shifter and operatively connected with the second splitter to receive the quadrature ( $Q_{P2}$ ) component.

23. The device of claim 10 further comprising an analog to digital converter operatively connected between the receiver and the processor.